

4-D Analogue Modeling of Transtensional Pull-Apart Basins

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Scaled sandbox models have been used to investigate the four dimensional evolution of pull-apart basins formed above under-lapping releasing stepovers in both pure strike-slip and in transtensional basement fault systems. The model results show that very different pull-apart basins are developed in transtension compared to those formed by pure strike-slip. Both types of models produced elongate sigmoidal to rhomboidal pull-apart systems above the basement stepover. However pull-apart basins developed in transtension are wider and more complex than the pure strike-slip pull-aparts. The pull-apart basins are bounded by a series of en-echelon faults that coalesced and linked as displacement on the principal displacement system increased. Subsidence was focused into discrete depocentres within the transtensional pull-apart basin, whereas in the pure strike-slip pull-apart basin subsidence was confined to the center of the basin. In transtension, the cover fault zones above the principal displacement zones (PDZ) formed distinct narrow graben systems due to the extensional component of transtension. Serial sectioning and three dimensional volume reconstruction permitted analysis of the full 3-D fault geometries.

Sequential model runs to higher displacements on the PDZs allowed the progressive evolution of these fault systems to be evaluated. In cross-section transtensional pull-aparts are characterized by downward-narrowing, asymmetric V-shaped graben that progressively widen with increased PDZ displacement. Cross-basin fault systems that kink the offset PDZs form much earlier in the transtensional basin evolution as compared to pure strike-slip pull-apart basins. The transtensional pull-apart models compare closely to natural examples such as the Sea of Marmara pull-apart system, Turkey.